1. Using analytical methods calculate the following for the given set of tasks:

- Calculate the system hyperperiod: which value = Least Common Multiplier of all tasks periodicities:

Button_1_PERIOD	50
Button_2_PERIOD	50
Transmitte_PERIOD	100
Receive_PERIOD	20
LOAD_1_PERIOD	10
LOAD_2_PERIOD	100

  Hyperperiod=100

- Calculate the CPU load:

  -"button1_monitor" & "button2_monitor" tasks execution time: 14 uSec (2 Hyperperiod)
  -"periodic transmitter" task execution time: 18.8uSec (1 Hyperperiod)
  -"UART receiver" task execution time: 22.3 uSec (5 Hyperperiod)
  -"load1_simulator" and "load2_simulator" tasks execution time: 5 mSec (10 Hyperperiod) and 12 mSec (1 Hyperperiod)

  CPUL= ((14 µs * 2) *2 + 18.8 µs + 22.3 µs *5) + 5 ms *10 +12ms /100 ms)*100%

  =136 µs +50 ms+12ms /100 ms *100% = 62.136%

- Check system schedulability using URM:

  $U \leq n[\,2\,\hat{}(1/n) - 1]$, n=6 --> $U\mathrm{rm}=6(2\hat{}(1/6)\text{-}1) = 0.734$

  U = ∑ Ci/Pi = 14 µs / 50 ms+14 µs / 50 ms+18.8 µs / 100 ms+ 22.3 µs/20 ms+5 ms /10 ms + 12 ms / 100 ms = 0.620748

  , Then U < $U\mathrm{rm}$ → it's **Schedulable** Systems.

- **Check system schedulability using time demand analysis techniques (Assuming the given set of tasks are scheduled using a fixed priority rate -monotonic scheduler):**

- Assumes only periodic tasks are used
- D <= P
- Zero context switch time
- Equation

$$w_i(t) = e_i + \sum_{k=1}^{i-1} \left\lceil \frac{t}{p_k} \right\rceil e_k \quad for\ 0 < t \le p_i$$

W = Worst response time
E = Execution time
P = Periodicity
T = Time instance

T1= Button_1_PERIOD	50,	E=14 µs
T2= Button_2_PERIOD	50,	E=14 µs
T3= Transmitte_PERIOD	100,	E=18.8 µs
T4= Receive_PERIOD	20,	E=22.3 µs
T5= LOAD_1_PERIOD	10,	E=5ms
T6= LOAD_2_PERIOD	100,	E=12ms

- Assume the following task using a fixed priority (High to low):
- T5 {P:10, E=5ms}, T4 {P:20, E=22.3µs}, T1 {P:50, E=14 µs}, T2 {P:50, E=14 µs}, T3 {P:100, E=18.8 µs}, T6 {P:100, E=12ms}

1. Task5 load_1_simulator:
   W(1) = 5 + 0 = 5
   W(2) = 5 + 0 = 5
   .
   .
   .
   W(10) = 5 + 0 = 5

   Assume deadline = P: W(10) = 5 + 0 = 5 < 10, So Task 5 is **Schedulable.**

2. Task 4 UART receiver: W(1) to W(20)
   W(20) = 22.3µs + (20/10)*5ms=10.0223ms < 20, So Task 4 is **Schedulable.**

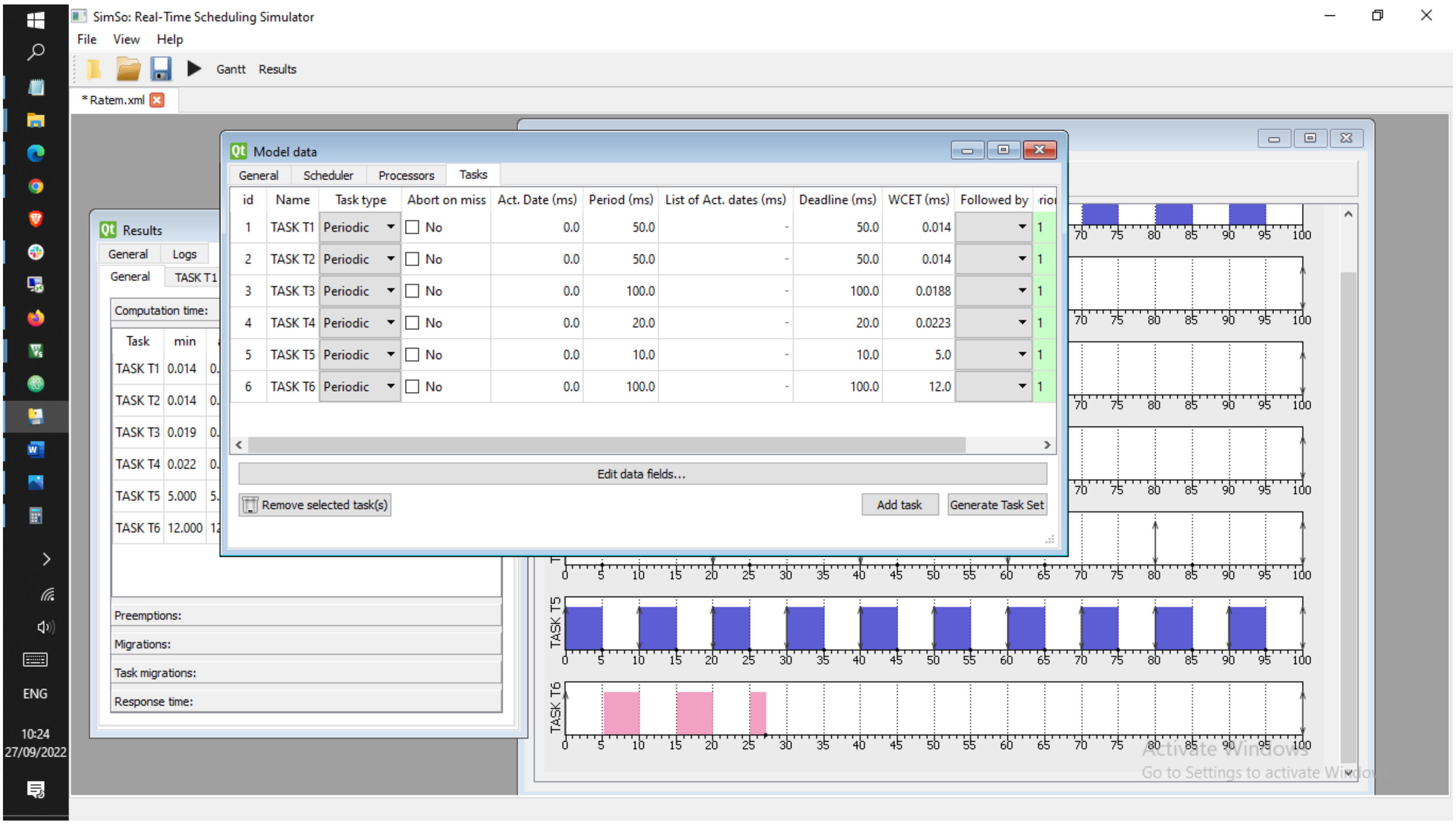
3. Task1 button_1_monitor: W(1) to W(50)
   W(50) =14 μs + (50/20)* 22.3μs + (50/10)*5ms =14 μs +66.9μs+25ms
   =25.081 < 50, So Task 1 is Schedulable.

4. Task2 button_2_monitor: W(1) to W(50)
   W(50) =14 μs + (50/50)*14 μs + (50/20)* 22.3μs + (50/10)*5ms
   =14 μs +14 μs +66.9μs+25ms
   =25.095 < 50, So Task 2 is Schedulable.

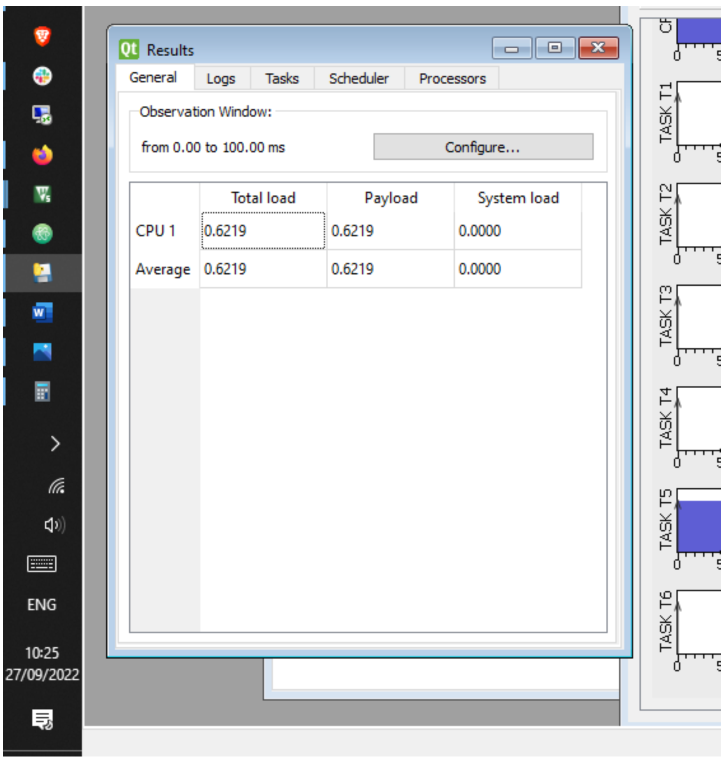
5. Task3 periodic transmitter: W(1) to W(100):
   W(100) = 18.8 μs + (100/50)*14 μs + (100/50)*14 μs + (100/20)* 22.3μs
   +(100/10)*5ms
   =18.8μs + 28μs + 28μs + 111.5μs + 50ms
   = 50.186 < 100, So Task 3 is Schedulable.

6. Task6 load_2_simulator w(1) to w(100):
   W(100) = 12ms+ (100/100)*18.8 μs + (100/50)*14 μs + (100/50)*14 μs
   +(100/20)* 22.3μs + (100/10)*5ms
   = 12ms + 18.8μs + 28μs + 28μs + 111.5μs + 50ms
   =65.186 <100, So Task 6 is Schedulable.

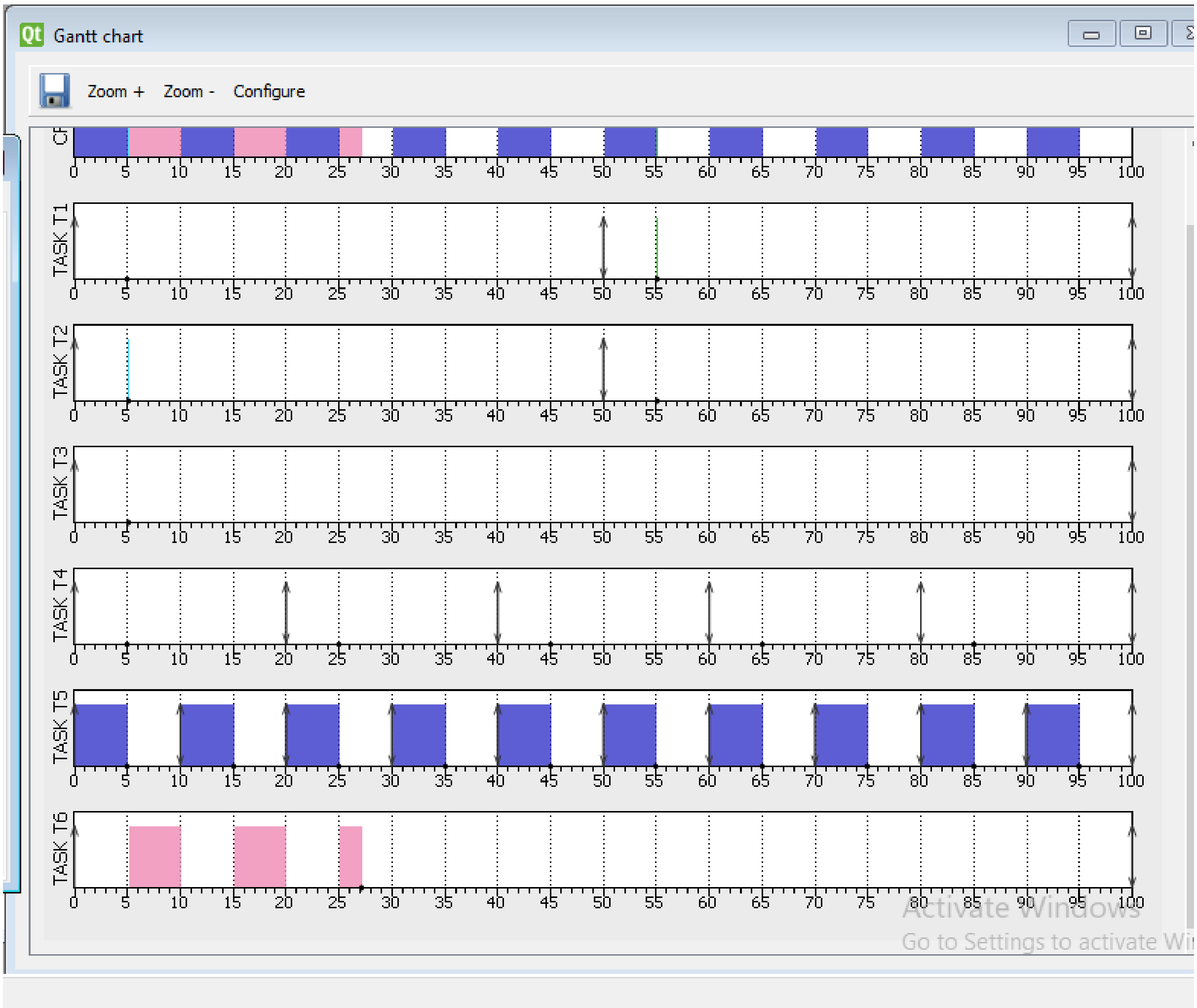
2. Using Simso offline simulator, simulate the given set of tasks assuming:



- CPU Load:

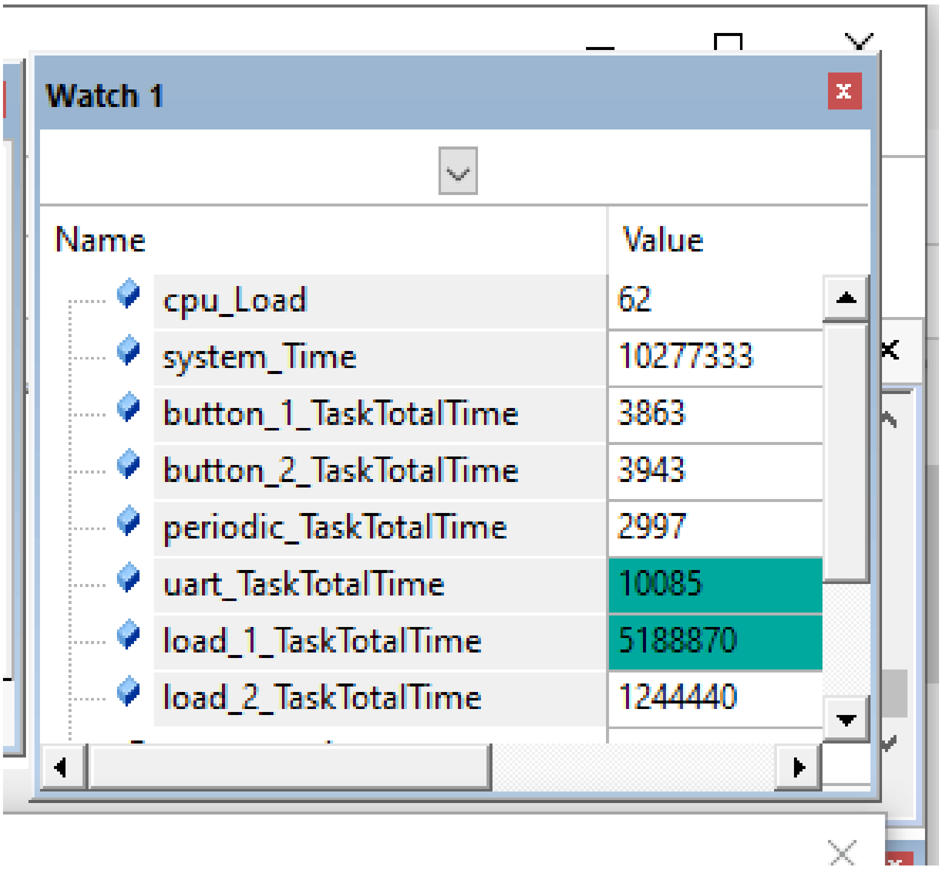


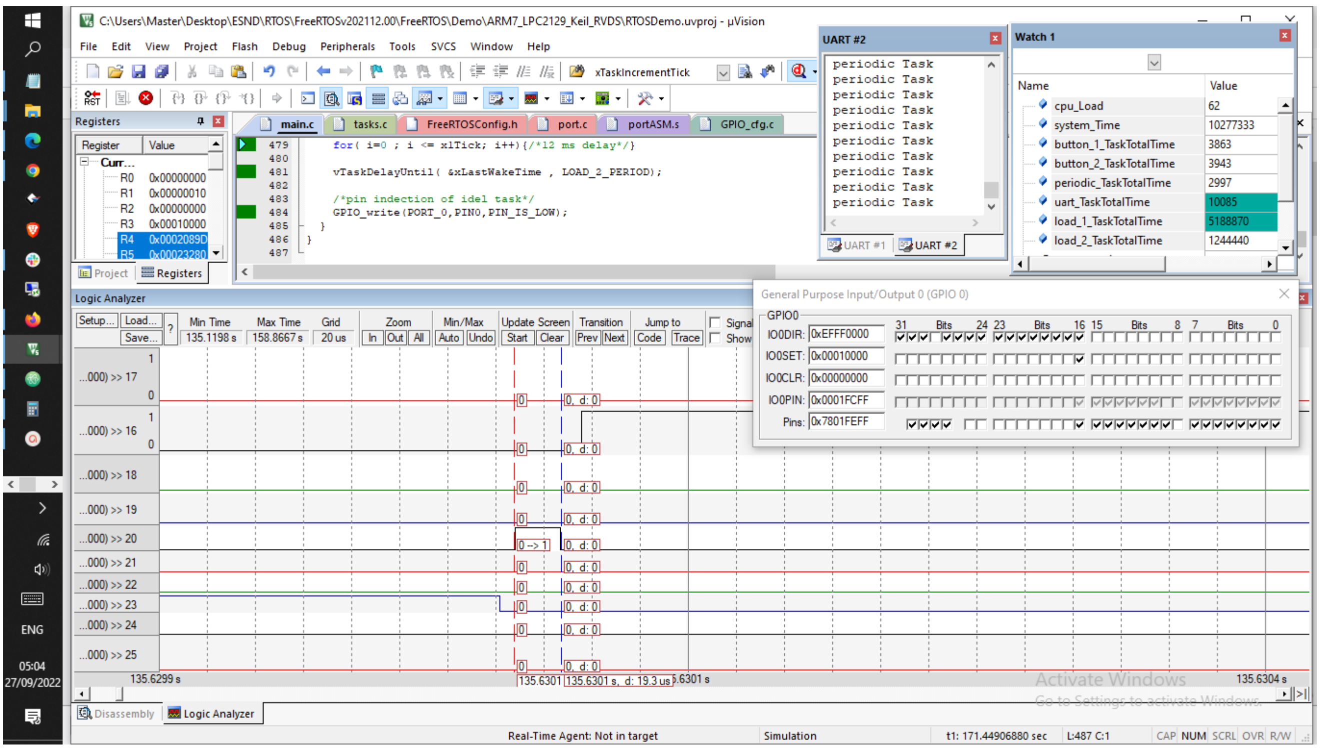
- Gantt chart



- CPU Load and Logic Analyzer

  The CPU load is 62% as showed, so the system is not too much loaded and worked successful.


Watch 1
Name
Value
cpu_Load
62
system_Time
10277333
button_1_TaskTotalTime
3863
button_2_TaskTotalTime
3943
periodic_TaskTotalTime
2997
uart_TaskTotalTime
10085
load_1_TaskTotalTime
5188870
load_2_TaskTotalTime
1244440


C:\Users\Master\Desktop\ESND\RTOS\FreeRTOSv202112.00\FreeRTOS\Demo\ARM7_LPC2129_Keil_RVDS\RTOSDemo.uvproj - µVision
File Edit View Project Flash Debug Peripherals Tools SVCS Window Help
UART #2
periodic Task
Watch 1
cpu_Load 62
system_Time 10277333
button_1_TaskTotalTime 3863
button_2_TaskTotalTime 3943
periodic_TaskTotalTime 2997
uart_TaskTotalTime 10085
load_1_TaskTotalTime 5188870
load_2_TaskTotalTime 1244440
Logic Analyzer
General Purpose Input/Output 0 (GPIO 0)
IO0DIR: 0xEFFF0000
IO0SET: 0x00010000
IO0CLR: 0x00000000
IO0PIN: 0x0001FCFF
Pins: 0x7801FEFF
Real-Time Agent: Not in target
Simulation
t1: 171.44906880 sec